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ACCOMPLISHMENTS AND FUTURE OF THE PHYSICAL SCIENCES[1]

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GENERAL ELECTRIC COMPANY

INTRODUCTION

THE promising study of mankind is man. I want direct your thoughts with that in mind, under the le, "Accomplishments and Future of Physical Science."

This means a hurried view of a lot of territory with eastern horizon at sunrise. Any single picture uld be inadequate. If I could make a "movie" of ny frames taken through an open mind, you would ll not distinguish science, but only a moving blur. ally to see things, we need about a twenty-fifth of a ond per frame. Science moves much faster than that. So any picture of accomplishments is neutral gray, much as newspapers appear feeding rapidly from a printing-press.

I shall select unrelated and peculiar pictures which do not seem to blend. By my poor lighting I lose detail, and by speed I spoil clearness. Perhaps also most important things are left out—spiritual things—but science is still a little confused there.

See first the animal itself, forced to experiment in order to keep alive. He tries, tests and names everything, but apparently creates nothing at all. He may *never* create, but he may continually put discoveries together in new ways. The log which saved him from drowning has become the steamship of to-day. His magic for keeping the wolf from the door—those pic-

[1] Address given on the occasion of the celebration of fiftieth anniversary of the founding of the Sigma Xi, rnell University, June 20, 1936.

tures he scratched on the cave wall—continues to work under improved conditions, and so we see the graphic arts, writing, printing and painting, still disclosing through new experiments additional ways of keeping that animal aloof.

My next picture is really a growing cerebral cortex. It seems to be the high-up part of the nervous system, which, in all animals, has grown more complex as the animal tried more and more experiments. It is some kind of record of impressions or sensations. This enlargement of his spinal column, overshadowing several other swellings on his main cord, is always reminding him, even when he is not struggling to keep alive, to try new combinations and to make changes just to learn how his environment may be better used. He seems to be creating his brain. So he now aims to improve things which are already good.

He next reduces labor, increases conveniences and adds to his physical comfort. Mental comfort is still for the future. By his successes it seems as though he aimed directly at the ends attained, and yet, when he finally imitates the birds, he flies in an entirely new manner. When he calls long distances or peers abroad or looks intently close up, he uses quite unnatural extensions of his original organs. These result from accidental observations which subsequently give him entirely new tools. Thus everything, including space, seems to grow smaller. And in our second picture he begins to research widely, just because he has seen the value of it.

In this picture we see our industrial research of the modern times. Much of it, too, was done to keep the wolf from the door, but there resulted such things as the controllable wind-pressure of steam, in place of oars and sails, and of harnessed lightning for every one's use. Things we call engines, for all heavy work, and machine tools of every kind (to displace or to extend hands) are parts of this picture, and the word "gadget" has come to stay.

The pure scientist is my next picture. He sees all truth as ultimately serviceable, and feels the boundlessness of it. He learns that unforeseen facts become valuable assets for improving himself and that his limitations lie in the growth-rate of his brain cortex. It is not alone gadgets that may be improved, but the designer himself. Therefore he is searching as never before for every particle of new truth, removing it from the infinite mass of the still unknown for its effects upon him. No encyclopedia can now include even the names of the modern products which form the life-studies of science specialists. No single mind can encompass the new work or even understand the new words at the rate they actually become necessary.

Twenty thousand members of Sigma Xi survey the boundaries between known and unknown over a broader area and by narrower angles than could be indicated by any compass-card, and they find in the tiniest atom an entire new universe.

And so we approach another picture, the future. We must try to predict from the past. How will man continue to experiment after his needs are supplied? Probably as heretofore, by finding new needs. Clearly he must improve the combination, from tools on the one hand to tool-holder on the other. There's no use fitting fine new adjustments to old style lathe-beds, for example. So he must go ahead, just ahead of his tools.

Judging from the past, we must picture continuous new experiments, yielding unexpected results, these in turn developing new human possibilities and providing needs for what we call "necessities," after the fact. This applies in countless ways, but a few examples will suffice. I omit community interests, sociological and economic research, mysticism and metaphysics, in order to touch a few changes in human chemical, physical, electrical, muscular, neurological, psychological and hereditary individual compositions. The mere words confuse one—they suggest so much. But man will proceed, in the fields which they represent, to try new combinations and to learn how he likes them after the event. He will graft into his cortex new thought, just as he has grafted new bone into his frame. The researches on nerve morphology will extend into mental improvements. He has learned scientific progress and will continually extend it. As long as he effectively reveres demonstrable truth the whole world will go along with him. It is in this immense territory of pure, unprejudiced research in countless divisions of physical science that you men will live and have your being. You will often sense the minuteness of your particular contribution, but dimensions are distinctly our artificial invention. Nature defies them. There are no little or big discoveries to be made, but only true ones. This suggests the wide gulf between pure science and existing metaphysical philosophy.

You may philosophize as you wish. Most people do exactly that! But true scientific work is not done that way. It takes the direct path of demonstrable truth. That is why your scientific publications refer to other people's related researches and seem cluttered with descriptions of possible repetitions. Wishful thinking and speculation serve as catalyzers but scientific work must not retain such admixtures. My last picture therefore will concern itself with man from his crudest sensory mechanics to his most wonderfully complex cerebral acquisitions.

Industrial Research

If industrial research were done by more and better people, we should have less unemployment and per-

haps none. This is perfectly obvious. There is, and always will be, an increasing circumference of untested assets about us and an infinitely fertile area for progress just adjacent to the known. At any instant the maturing of some new crop of facts, materializing in gadgets, may put new industries into action. The trouble with us is that there are too few and too poor industrial researchers. We have had inadequate mental backgrounds, too little appreciation of science, and too much urgency. In other words, in a world where we expect continual improvement, there is no quick and easy way to remove the hurdles. So I suspect striving to overcome hurdles may be a necessary part of the game.

But there will always be fresh opportunities for the new generation, so I wish now to make suggestions for the younger members of the society, and particularly for those who may contribute to the various industries.

Here the question quickly and forcibly presents itself: Is it enough in a research laboratory to tackle known difficulties, to improve output and to analyze competitors' methods and products? The answer is, No! And this leads to asking how far afield should a research laboratory go. The aims of the research group should include protection of the industry against the sure obsolescence due to new discoveries by some one. Discoveries made entirely outside an industry may disconcert and injure it. They may stop the earning power of conservatively invested capital. The harness men and carriage builders of the early days were more or less embarrassed by the oncoming automobile makers, because there was little in the harness or wagon business to anticipate the gasoline engine. Research on the old ground is not enough. One must assume that advances will be continually made in all industry and try to be party to it. The president of the Telephone Company, recently testifying before a committee of Congress, referred to many unexpected products of research, made by that company, which, almost unavoidably, put the company into new commercial developments like radio, talking motion pictures, etc. The discoveries were made in the course of far-sighted research, and, once their worth was seen, the new processes just had to be carried out and the new products produced. Otherwise some most important matter relating to the main interests of the company might have been overlooked. If, for example, radio in other hands had proved capable of rapid and easy house-to-house talking, with the discarding of wire circuits, great numbers of innocent investors in the Telephone Company who depend upon its stability might have been ruined.

Again, if our own company had not early undertaken expensive research work on radio and power tubes, we should certainly have lost our place in the industry which the high frequency radio alternator of Alexanderson had given us. The alternators were soon entirely superseded by power-tubes at greatly reduced cost, and it was fortunate that we took active part in that development.

Similar duties meet the automobile makers. This is illustrated by the studies they make of paints, stream lines, anti-knock gasolines, of Diesel engines and of every conceivable source of portable power just beyond the horizon.

Such considerations account, too, for our own development of photoelectric tubes, and, with them, of all sorts of devices depending on this electromechanical eye. Its study had become an essential part of the research work on vacua. We had to learn more about all vacuum tubes. So new electron tubes of widely diverse characteristics and capabilities came into existence, and soon all sorts of applications were found for them, from exploring the heavens for nebulae hundreds of millions of light-years away to producing artificial fever in the human body, and, in between, innumerable gadgets for automatic inspection, control, counting, sorting and regulating most diverse materials, products and processes. Thus the electric drive and control systems already marketed by the company have been made more useful, new systems made possible, and perhaps harmful competition in that field forestalled.

The great chemical concerns interested in gums, varnishes, paints and synthetic organic products, can not afford to be idle in the now fertile fields of new synthetic polymers, because many of these are proving superior to natural products. This is true whether it it for molded compounds, surface coatings, electrical insulators, fabrics or even rubber.

There are large investments in silk products in America. If the industry languishes, the doctor should suggest research, and research is now being carried on with many new artificial fibers where the wood of the tree is used instead of the leaves—a perennial supply instead of seasonal. There is no great probability that the complicated machinery of the tiny silkworm was designed to produce from mulberry leaves a product so well fitted for every changing *human* service that better products might not be found. One naturally looks for such discoveries to those experimenters who already know the applications and the limitations of existing products, so that each industry should be inquisitive.

The petroleum industry presents a similar condition. Not long ago its researches were being made by the Indian medicine man, who collected oil in blankets floated on Pennsylvania creeks. All he knew about his research was that it made "good medicine."

To-day complex organizations with skilled research

men and expensive apparatus detect hidden oil domes and apply novel processes of well-drilling and product-purification. Their highly developed tests of quality now include so much novelty that only specialists understand it. Such organizations are in the best possible position to value any new modification or substitute and to carry on syntheses which disclose unexpected products for future use.

Modern photographic research also well illustrates my point. We continually see cheaper and better products. Lenses and cameras are being rapidly improved. New optical properties and speedier emulsions are being discovered for landscapes and portraits, movies and colored movies. The texture is being made of finer grain so that more exact microscopic and telescopic reproduction is made possible and so the whole photographic industry flourishes.

All this is the conservative end of research. No one is better equipped to approach the novelty than those with so much local experience. The real researcher, the optimist, asks, Why not extend the photography out of sight?, while the conservative says, Why attempt to photograph what you can't see? No one can answer such "whys," but one is productive and the other is not. The closely contiguous fields of invisible light, the ultra-violet, the infra-red, the x-rays and the cosmic rays are in the offing, so you are not surprised to find a large photographic company busily investigating the invisible. There is probably no limit to such expansion, and I am hoping for some sort of x-ray photographs of muscles, of moving viscera and of nerves and arteries, just because these are the things next to our bones.

I ought to tell you how feebly I illustrate right research. I am tongue-tied. Research is the result of child-like inquisitiveness, and we are likely to check that inquisitiveness, as we do a child's because we are lazy. It is easier to plan experimental work close to the old home acre, so we do. In electricity, for example, I can think only in terms of wires, magnetic fields and wave-lengths, so I lazily encourage inquisitiveness only about adjacent areas. So much has been accomplished with 25 and 60 cycles and a few selected high frequencies in radio, and even with zero frequency itself, that wave-lengths between zero and infinity are subjects for research—simply adjoining fields. But this, too, discloses laziness, ignorance and conservatism, because I have thought only of the obvious. I may have actually forgotten that I never knew what electricity is, and am ignorant of what it might do if freed from the shackles which limited knowledge has forged. We almost need to provide more "accidents," for it is frequently the unexpected effect which drives a researcher into a new and productive field.

So I suggest to young listeners to do pioneer, inquisitive research work in the field opened to them and let others do most of the repeat and repair work. It is almost a question whether you ought not be warned against too great efforts expended on long-wanted or prescribed needs. Engineers in any field can easily misdirect a young research man's efforts against impenetrable walls. A long-felt want, like perpetual motion, the philosopher's stone, the fountain of youth, workless weeks, frictionless motion, water substitutes for motor fuel, fireproof organic matter, black metals and other undiscovered chemical elements are not the most promising targets for research. If a want has been felt long and persistently, it is possible that sufficient heads have already been broken over it. It is distinctly more fun, and perhaps more profitable, to utilize things in your own field that you didn't suspect would be needed, even products you didn't suppose could exist.

For youngsters in research I suggest more education and greater specialization. Discoveries and interesting work easily start at the outer edges of the known. Explorers leaving the home-town take modern carriers to reach "the open," with the tall trees. They later have to walk some, too. They may view the waterfalls or fertile fields as accidental discoveries, but such things are fixed by inviolable laws, which may be learned. Just as our former open spaces are now partitioned into states, cities, towns and farms, so science became chemistry, physics, biology, etc., and these in turn multiply and subdivide, putting the most promising values among the younger offshoots.

I wish there were some way to lift the innocent boondoggling leaf-duster from the highway into research in medicine, for example, but he would be in the way and get run over. Even to be interested in medicine now calls for knowledge of advanced chemistry, physics and what not, and the same applies to most other active fields.

Pure Research

It is impossible to anticipate science, its consequences and industrial developments. It continually discloses new possibilities, most of which can not be foreseen at all. The wisest man of Queen Elizabeth's active reign, Francis Bacon, tried to describe all the possible novelties which orderly research might disclose. He incorporated his prediction in a short story, "The New Atlantis." He wrote that story to convince people of the value of experiment. It popularized science. He had already tried, by the more pretentious publications, "Advancement of Learning" and "Novum Organum," to educate people. He plainly felt that he had shot over their heads. So the accidentally discovered island, in his popular story,

made use of such unheard-of advantages as horseless carriages, sailless ships, submarines, human wings, etc. He apparently exhausted himself by his suggestions of desirable but undiscovered things. But no one can exceed his number even now. It is so difficult to think in terms remote from experience. There were over twenty widely different predictions and all but one have been realized. That one seems simple. It is a filter to take potable water from the ocean. That this has eluded research so long does not make it insoluble, but it indicates limits to describing the impossible.

Scientific research is fishing with a tiny scoop-net in oceans of unfathomable depth and infinite area. We make the nets ourselves. Our catches often make a disordered pile, but we may orient them and fit them together as we do jigsaw puzzles. Then some one may give our puzzle one more dimension, like depth, and then we have a new necessity.

It may not have helped aeronautics much for Bacon to make his islanders fly somewhat like birds, but he certainly gave research a first and lasting boost. He may not have written Shakespeare, but suspicion attached to him because he was so wise.

After centuries of research it has been recently said by Hans Zinsser, "There is no just reason to believe that we, transitional creatures in the upward progress of evolution, have reached the highest possibilities."

I doubt if it is recognized that the average research worker is a healthy, justified kind of unselfish communist. He aims at everything and works for everybody. He pays personally for the spread of his propaganda and broadcasts freely all his home-grown produce. He pays for the publications by supporting the scientific societies which publish for him (if his written work passes their critical examinaton). Moreover, he is charged extra for reprints of his own scientific papers, and he has established the commendable custom of exchanging freely his reprints with brother scientists. Prodigal teachers and unselfish pure researchers do their individualistic work and pay twice for telling the world. The expense to a good worker may exceed several hundred dollars a year. The better he does it, the more it costs him. I do not know of any other such self-sustained and useful group. In science publications, note the growth merely in chemistry. In 1907, *Chemical Abstracts* published reviews of about 8,000 new papers, about 15,000 in 1920, about 25,000 in 1927, 32,000 in 1930 and 42,000 in 1935. In biological science, for example the reviews have jumped from 7,000 in 1931 to 10,000 in 1935, and it is clear that this is going to be a most active field.

Sigma Xi is not particularly interested in technical research, nor is that especially exciting. What is exciting is the discovery of new facts among the mind-expanding wonders of creation. What do we care about applications of cosmic rays, for example? The wonderful thing is that they exist, have such remarkable properties and speak an unknown language which we may be able to learn through great effort. The so-called pure science encourages its devotees by endowing them with something of a creator's interest and a forever unsatiated, even unsatisfied longing. It is a desire to observe, to know, to understand, to construct, to measure, to conquer by self-effort. As I have seen scientists at work, I have often marvelled at the remarkable forces which keep them concentrated in their individual fields. It is as though they instinctively felt that throughout the unending future their contribution to knowledge would grow forever, through developments which could not be preconceived by any one. I suppose every one of our mundane commercial developments first passed through the inquisitive experimental hands of some highly individualistic inquirer without fixing in his cerebral cortex any so-called practical application. As with kitchen gadgets, it isn't so important who discovered the thing nor what it does, but the bearing it has on our real improvement. When all is said and done, there seems one thing worth advancing, and that is the man and his mentality.

It is easy to imagine such a new series of improvements as would practically free us of physical effort. A mere local extension of available stock may arrange things so that machines do all the real work. The coal burned at the mine and the electric current used in the most advantageous places might let every one bask in southern sunshine in winter and fly back north in the spring. But we may be built for something better and much more enjoyable. The processes of greatest interest lie within our cerebral fields, and as this is central station for our nervous system, and as I am interested in certain aspects of nerve actions, I wish to illustrate pure research by a few selections from that particular area. This serves both to illustrate broad research and is a movie, as it should be.

We ourselves are our nerves, except for a lot of common mechanics, and our happiness is bound up with their behavior, whether we talk about simple reflexes or complex brain networks. Research has gradually traced out more and more of these electrical conductors and their interconnections. Their number exceeds all power to count. They serve us our pain. They measure us our pleasure. They predetermine our most refined thinking, and they are made by us for us. They interpret both mind and matter, and they stand for "free will."

I shall narrow down my wide-spread remarks to a few cases. I want to trace lightly the relations between common cold-feet and mental gangrene, between

chemical hormones and knowledge and judgment. Connecting them thus is anticipating future research, but that is my aim.

Our nervous system is divided into three parts, though it is built as a unit. The autonomic system operates a pair of lines and central stations (ganglia) down the trunk parallel to the spine. They are connected to the main or voluntary system within the vertebral column, so in turn to various parts of the brain, and finally to the top—the captain's bridge, the cortical layer. Another nerve group, also outside the spinal column, courses down from the midbrain to the various viscera, and cooperates and competes with the rest of the automatic system in trying to keep a fixed or healthy state within the dried skin bags in which our colonial cell immigrants have to cooperate, as Cannon sees it.

This para sympathetic and the ganglianated sympathetic are the antique wiring systems of the early animal. By their continued efforts, now usually quite outside our consciousness, they preserve our temperature, our combustions, our compositions, etc. Dr. Cannon calls this "homeostasis." It is as though we once knew how to control and mold ourselves, but, after developing thinking nerves we delegated the less important visceral control to automatic mechanisms. Of course this new cerebral or voluntary system is the most interesting. If we depended solely upon the autonomic system, wonderful as it is, we should be at a comfortable standstill. We should all be stable and uniform, but we'd never get anywhere or have anything new. Judging from the nervous system as a whole, we are designed for change and growth; in other words, for something better. If we are not getting better we are doing wrong; that is, we are becoming mentally or physically ill.

Let us consider first the defects of our machine.

There are a number of maladies which are persistent and nearly incurable. They are among the oldest troubles the race has known. Rheumatism, arthritis, asthma, angina pectoris, osteomalacia, poliomyelitis, Raynaud's and Buerger's diseases, epilepsy and high blood pressure are some of them. A part, if not all, have the peculiar property of being due to spasmic, irregular behavior of the homeostat and of leading to irreversible structural changes. It has been discovered that this peculiarity is often traceable to nerves. "Wires are down," "shorted" or carrying too much load. The insulation may be "all shot," as electricians say. To check this thought, surgeons are cutting selected nerves, and much is being learned thereby. Sometimes, after the removal of part of a nerve (or wire) or even several ganglia (or small switchboards), the rest of the automatic circuit proceeds to do the whole job better. It readjusts things and the patient gets well. I suppose this is because we are provided, as is a battleship, for example, with many repair parts and auxiliary, even hidden, circuits for just such accidents. New wiring connections are automatically made when the demand is insistent.

Raynaud's disease, which is one of these spasmic nerve disturbances, starts with cold feet and often leads to gangrenous toes and then to surgical operation. The blood circulation is reduced, not by calcification of arteries (sclerosis), nor by internal organic deposits (*thrombo angiitis obliterans*), but by irregular nerve control. Leading experts now raise the question, What gets on the nerve? It looks like worry. Further research is indicated, for if mental trouble reduces circulation to a foot, why not also to a brain? The surgeons successfully cut the wiring for Raynaud's disease, therefore they try it for other spasmic maladies. Surgical literature shows that such study is now well under way. But this is really taking place before we know how nerves perform their work and how they share it in their multiple electric circuits.

Surely we ought to do more research on the actions of our nerves.

Throughout this field, a few researchers are busy, as illustrations show. For example, the heart is speeded up by adrenalin, which enters the blood from a gland which is under sympathetic nerve control. But the heart is also retarded by the vagus nerve, which acts independently. The proper heart balance is thus automatically and unconsciously due to nerve action. Do the nerves act like mechanical clamps, electrical devices or chemical products? Here some wonderful researches are already being made. It has been shown that less than one part of adrenalin per billion of blood accelerates the heart. Similarly, also, blood passed through a heart retarded a second, isolated heart by mere solution-contact. This shows not only the physical chemical effects of the hormones which circulate within the blood, but also indicates that the local action of nerves, like the vagus, is probably also due to chemical products. Nerves produce chemicals for stimulation. As this stimulation can be brought about electrically, I became interested.

In this connection I must refer to G. H. Parker's work, which I hoped he would describe at this meeting. It illustrates the importance of distant pioneering. It makes one gleefully accept long, new names for useless things. This part of my "nervous" talk I call the embarrassed fish. No one knows much about it. Some humans get embarrassed and blush. So also do shrimp, frogs, salamanders, fishes, etc. This is nervous, protective coloring. A black bullhead, when transferred to a white dish of water, nervously lightens his skin. Under the microscope the mecha-

m of the process is seen in the contraction of a lot black spots in the skin (melanophores). When se are expanded the color is black, but when ad- ed by messages from the optic nerve they contract d the animal becomes light-colored. In the case the embarrassed shrimp, its eye stalks have been moved and extracted with water. This solution, en injected into an unembarrassed shrimp, pro- es the anticipated change in its color. Finally, d very significantly, Parker has shown that in cer- n cases the chemical nerve-product is not soluble in ter, but may be extracted by oil, so by injecting oil-solution into other fish the color becomes nged near the treated spots.

This is one of the many cases where the immisci- ty of oil and water is emphasized and utilized in ure. It is not new that fats are oils, and that tact between the two is common in animals and nts. Probably many processes of growth depend the presence of the pair in contact. Surely nature adapted itself to this mixture and adopted its endable properties. So while we may never com- tely understand their functions, we like to consider m just the same. The oils may carry in solution npounds insoluble in water. The aqueous plasma ries salts insoluble in oil. When the two solutions ne into contact, new compounds of the two com- ents may be found. Such reactions may well be ely connected with nerve action, as they probably with tissue growth, calcification, etc. This makes e of Langmuir's researches on molecular films bly interesting to me. For example, an inert oil ts as a lense on water. If a little stearic acid dissolved in the oil, and if the water contains a e calcium, there is formed at once a film of calcium rate which is quickly forced out from the oil- er surfaces and grows to a compact molecular film the water. This film neither the water nor the oil ms to care any further about. Perhaps this is a t of the picture of growth. At any rate, it lies the extremity of current biological science.

Cannon looks "forward to new triumphs of phy- siologic investigation, and that fair prospect lies in the direction of the nervous system." This is scientific modesty. Knowing much less of the subject, I am not so careful. All our troubles and pleasures are in the final analysis neural. From the pain of a cold toe to the happiness of some constructive process, our nerves are the necessary generator and network. From dreams of avarice to indigestive nightmares, all the information comes to nerves through nerves. Moreover, all the storage of past records lies probably intact in nerve structures and might be available if we better knew the system.

The nerve groups which control our insides willy nilly, without consulting our cerebral system, seem to differ in themselves as though competition were neces- sary even for the smallest organ. Chemists under- stand balanced reactions and know that the equilib- rium condition is not idleness but represents stability, just because two necessary reactions are doing all they can in opposite directions. This proves that good living itself is process rather than product. Re- searchers discover that one group of nerves cooperate with ductless glands and the heart to keep the blood supplied with various catalyzers, which react on all the organs both to buck them up and tone them down. And as though this were insufficient, the parasym- pathetic part of our automatic outfit gets in its work by quickly supplying particular organs, modifying and controlling chemical products which refine, correct or overrule, where needed, the general actions of the less exacting and more diffuse sympathetic system. Probably all processes that proved desirable, among those of the simpler nerve-system, were adopted into the cerebral system as it developed from the lower states of man. So some day we may begin to see how beer and pretzels change into music, arts and science—or Brahms, Cellinis and Pasteurs.

Just imagine how far such studies might extend! I have thus speculated at this point, because I am speaking of the future of physical science.

THE CONTRIBUTIONS OF ARTHUR A. NOYES TO SCIENCE

By Professor MILES S. SHERRILL
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

N old letter came to light, by the merest chance, one week to a day before Arthur Noyes died. It dated November, 1901, bore his familiar signature, been dispatched from Boston to a student in Leip- and contained the following paragraph:

. I have made a proposition to the President tchard, M. I. T.] in regard to the establishment of a Research Department. It is rather an audacious proposition to make for a person who hasn't much more property than the obligations involved in the proposition require, but I feel the highest ambition of my life would be realized if I were in charge of such a department, and it is a favorite sentiment of mine that:

''Those love truth best who to themselves are true,
And what they dare to dream of dare to do! . . .''[1]

[1] The italics are those of A. A. N.

This paragraph reveals much of the man—of his vision, his courage, his passion for research, his humor, his unquenchable idealism. Subtly, too, it evidences the means by which he was so adept in passing—from mind to mind, from teacher to student—the inspiration to dare and to do. Most striking of all, perhaps, is that the whole paragraph reflects, quite without conscious intent, that inescapable forward surge of spirit which was to make him preeminent in three fields, education, research, leadership.

The "audacious" proposition was accepted. Arthur Amos Noyes, aged thirty-seven, became the director of the first Research Laboratory for Physical Chemistry in America.

His scientific career began in 1886, when he completed under the guidance of L. M. Norton his bachelor's thesis in organic chemistry at the Massachusetts Institute of Technology. The results were published with Professor Norton under the title, "The Action of Heat on Ethylene." In the following year he completed and published his master's thesis.

He then went to Leipzig intending to pursue graduate work in organic chemistry under Wislicenius. While at work in this laboratory he attended lectures by Ostwald in the newly created field of physical chemistry. Quick to grasp the great opportunities afforded by this rapidly growing subject he made the momentous decision to transfer to Ostwald's laboratory.

Research in physical chemistry of that day was largely influenced by two very recently advanced theories, the van't Hoff theory of osmotic pressure (1886) and the revolutionary Arrhenius theory of the dissociation of electrolytes into ions (1887). The Arrhenius theory especially was being subjected to quantitative test by pioneers in this field the world over, but Leipzig, due to the fame of Ostwald, had become the center of such activities.

In the year 1890 Noyes published three papers which led to the doctorate. In the first were discussed, from a theoretical view-point, causes for the deviations of non-electrolytes at higher concentrations from van't Hoff laws of solutions. In the second were presented the results of experiments made to test the validity of the constant solubility-product principle, which had been just formulated by Nernst, then a young privat-dozent in the laboratory. The third paper was published with LeBlanc and dealt with solubility and freezing-point determinations.

Enthused by his Leipzig training, tremendously inspired by Ostwald, Noyes returned to America, where his influence upon education and science constantly increased in scope and in importance. The establishment of the Research Laboratory of Physical Chemistry (1903); the acceptance, somewhat reluctantly, of the acting presidency of Technology (1907); resumption of control of the Research Labora after his successor was chosen (1909); the assu of concurrent control of two laboratories, his own the Gates Chemical Laboratory in Pasadena (19 the selection as acting chairman of the National search Council (1918), were important points in career. The most far-reaching change, however, in 1919, when he definitely decided to sever con tions with the Massachusetts Institute of Techno in order to devote his undivided effort to the new fornia Institute of Technology. This decision w very difficult one for him to make.

During the period preceding the establishmen the Research Laboratory, Noyes taught success *analytical, organic* and *physical* chemistry, publis in each subject a book: "Qualitative Analysis o organic Substances" (1895); "Experiments on Reactions. The Identification of Organic Substan with S. P. Mulliken (1899); and "The General ciples of Physical Science" (1902).

His "Qualitative Analysis" received immediate ognition, and its wide acceptance did much to fam ize chemists of that day with the ionic theory an laws of chemical equilibrium. The original sche analysis was incomplete in the sense that it pro for the separation and detection of the commo ments only. Many of the omitted elements were, ever, of common occurrence in nature, and each new uses were being found for them. Further the scheme provided no satisfactory tests for es ing, even approximately, the relative quantities elements qualitatively detected.

Foreseeing future needs, Noyes initiated an sive research project to devise a complete sche analysis which would include the so-called rar ments and would put qualitative analysis on a quantitative basis. In 1902 he wrote in a pe letter: "Sammet and Ober are working with rare metal—qualitative analysis. We have lately working on a *general* method of preparing the so for analysis by using hydrofluoric acid in v ways, but have met a great many very trying culties. But I think in the end we shall succeed.

This marked the beginning of a long seri investigations carried out with the help of Bray and many other skilful collaborators. investigations were published from time to time work progressed. There was finally published Bray, after a quarter century of effort, a monum treatise of over 500 pages entitled, "Qualitative sis of the Rare Elements." Noyes himself re this as his most important contribution to che

The second book marked the conception of plan, wonderful if successful, to systematize the

lexities of knowledge of the empirical properties of rganic compounds. This extremely important sys-ematization was subsequently developed by Mulliken, ut Noyes always retained a deep interest in it.

The third book was the first step in the pedagogical evelopment of what became later an exemplification f Noyes's conception of an ideal method of instruc-on in physical chemistry. The purpose of such a ourse was to give the students an intimate knowledge f fundamental chemical principles and a training in *gical, scientific* thinking such as would enable them attack effectively the practical problems arising in eir subsequent educational or professional work in ny of the branches of chemistry or the related sci-nces. He proposed to accomplish this purpose rough the use of a text interspersed with problems hich would prevent the student from memorizing the rinciples or complacently believing that a formal nowledge constituted a real understanding of them. e believed it desirable to supplement the classroom ercises (preferably of the recitation type) with a ief laboratory course, or with lecture experiments, hose primary purpose should be to give concrete lustration to the basic phenomena under considera-on.

It was my privilege, from 1905, to aid in the devel-pment of this course. After years of experience with r own classes Noyes and I published in 1922 "An dvanced Course of Instruction in Chemical Prin-ples," in which these ideals were embodied. Noyes as also largely responsible for the experiments de-ribed in the supplementary laboratory text published y me. Since 1922 further development of the course as been continuous. At the time of Noyes's death a bstantial part of a rewritten and rearranged second lition had been completed and printed for the use f classes at C. I. T. and M. I. T. This course in emical principles is the main contribution of Noyes pedagogy.

Noyes, through his research in physical chemistry, ampioned the cause of the ionic theory when many emists sought to discredit it. He instigated an tensive research program for the systematic study f the nature of electrolytes by precise measurements f the *solubility* of various types of electrolytes in the resence of others; of *transference numbers;* of *elec-ical conductivities* covering a wide range (0° to 06°) of temperature; and of *chemical equilibria* and *ectrode potentials.* Such investigations supplied a mprehensive knowledge of the ionization relations f different types of electrolytes upon which their emical behavior in solution depends. Though the sults confirmed the ionic theory in its more general pects, the strong electrolytes showed puzzling nomalies.

In 1904, Noyes, after a critical analysis of all data then available, concluded that the ionization of salts is not primarily determined by chemical affinity, but by the magnitude of the electric charges on the ions. He was *almost* convinced that salts are completely ionized up to moderate concentrations, and that the decrease in conductivity is due merely to a change in migration velocity.

When Debye and Hückel, in 1923, advanced their theory of complete ionization of salts and of inter-ionic attraction to explain the changing migration velocity with dilution, and the abnormal chemical behavior of ions, Noyes immediately became deeply interested. He published (1924) a long article giving (1) critical presentation of the theory; (2) testing of the theory with experimental data. These data were obtained for the most part from his own earlier inves-tigations. This article was soon followed by two more, one of which tested the theory in alcoholic solutions and the other applied its principles to evaluate from conductance and transference data the ionization and ionization constants of moderately ionized substances.

When Noyes became convinced that the basic ideas of the ion-attraction theory were correct, he consid-ered his own contributions to the theory of electrolytes as finished, and gave his whole-hearted interest and support to the newer lines of physico-chemical re-search—*rate of reaction, crystal structure, photochem-istry, application of quantum mechanics to chemistry*—conducted by the various members of his staff. Per-sonally, however, he continued to investigate with his *Honors* students the equilibrium conditions of oxida-tion-reduction reactions; and, in spite of great physi-cal suffering he published during the last two years of his life several articles in this field. His final paper on strong oxidizing agents in nitric acid solutions was submitted for publication about one month before his death on the third of June.

The active participation of Noyes in the affairs of the American Chemical Society furnish the first con-crete evidence of his leadership in science. In 1895 he published the *Review of American Chemical Re-search* as a part of the *Technology Quarterly,* of which he was editor. In 1897 this review was incor-porated in the *Journal* of the American Chemical Society, Noyes continuing as editor until 1902. It was replaced by *Chemical Abstracts* in 1907. Thus Noyes inaugurated the first abstract journal covering American chemical research, the precursor of *Chemi-cal Abstracts.*

Noyes also took an active part in the organization of the Northeastern Section, and in February, 1898, became its first president. He presented to the sec-tion, over a period of seven years, five papers—two illustrated by experiments and all related to his own work or that of the Research Laboratory. In 1904 he was honored by the presidency of the parent society.

A similar account might be recorded of his participation in the councils of the American Association for the Advancement of Science and of the National Academy of Sciences. In 1927 he was elected to the presidency of the former organization.

The trek to Noyes's first Research Laboratory began immediately after its establishment. The roster of these youthful investigators—"which now reads like a membership list of the National Academy of Sciences"—has been too often cited to require mention here. Through this distinguished group Noyes's influence spread in ever-widening circles.

It was, however, George Hale who first fully appreciated the potentialities of Noyes as a leader in education, and solicited his aid in the reorganization of Throop College in Pasadena. In securing also the cooperation of Millikan he brought together with himself two men whose combined qualities were ideal. Under the guidance of this trio has been created one of the greatest research and educational centers of the world.

Here Noyes brought to fulfilment some of his most cherished ideals of education. To cite but one, he introduced as a general policy his own life-long practice of *selecting* the ablest students, of *interesting* them in discovery and of *training* them in research early in their undergraduate course. The yield of effective research men obtained by this treatment of so-called honors students was a matter of great significance to him.

The last, and almost the greatest departmental interest of Noyes was the development of a division of bio-organic chemistry. Realizing that the applications of chemistry to biological problems would become more and more important, he became deeply interested in the study of chemical compounds having biological import. He published with H. W. Estill (1925) a paper on "Effect of Insulin on the Lactic Fermentation," and sponsored the extensive work on insulin conducted by J. J. Abel at the institute. (R. C. Tolman writes that it is the hope of the department to develop further this last-mentioned interest of Noyes, when the Crellin Wing of the Gates Laboratory is completed.)

During the years spent in California, Noyes's interest in science in general widened. He was devoted to Hale and to the success of the 200-inch telescope. He was a member, not only of the executive council of the institute, but of the observatory council, which has direct responsibility for the telescope. In his quiet and unobtrusive way, he exerted a profound influence in all departments. The educational policies, both graduate and undergraduate, were largely due to him. As Millikan has said, "he spent more time than any other man on the campus trying to create here outstanding departments of physics, of mathematics, of the humanities, of geology, of biology and of the various branches of engineering, and what these departments are to-day they owe, more than they themselves know, to Arthur A. Noyes."

SCIENTIFIC EVENTS

THE CROCKER EXPEDITION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE American Museum of Natural History, through the generosity and with the collaboration of Templeton Crocker, of San Francisco, is planning an expedition to Christmas Island, Samoa, and, incidentally, certain islands of Hawaii, to obtain material for new group exhibits for the Hall of Ocean Life and the new Whitney Memorial Hall of Pacific Bird Life.

Mr. Crocker sailed on the yacht *Zaca* from San Francisco on August 18 for Honolulu, where he will be joined by Dr. Roy Waldo Miner, curator of marine life in the museum, and his party, consisting of Chris E. Olsen, artist and modeler, and Wyllys Rossiter Betts, associate on Dr. Miner's staff. William F. Coultas, of the department of birds, will accompany the expedition and will have charge of the ornithological work. Mr. Crocker will be accompanied by Toshio Asaeda, a skilled artist and photographer.

Dr. Miner plans to collect materials and make observations for a pearl fisheries group, to be installed near the great coral reef group he has recently completed after twelve years' work and five expeditions to the Bahamas. The proposed new group will represent a pearl bed on the floor of the sea, with native divers engaged in collecting the pearl shell. For this purpose the expedition will visit Christmas Island, a large coral atoll situated about 2° north of the Equator and 1,200 miles south of Honolulu; it is about 40 miles in diameter, with a central lagoon where pearl shell grows in the midst of the coral formation. Paul Rougier, the owner, has put the island and all its facilities at the service of the museum for the purposes of the trip. Dr. Miner and his assistants will utilize diving helmets and undersea cameras to obtain motion and still pictures of the undersea life of the lagoon for faithful reproduction in the new American Museum exhibit. Oil-color sketches will be made under sea by Mr. Olsen on specially prepared and mounted oiled canvas, and wax models of the brilliant fishes of the region will be constructed as part of the group setting.

After completing this phase of the work the expedition will proceed to Samoa, where Mr. Coultas will make special studies of the birds of that region and

obtain accessories and photographs for a Samoan bird group, while the marine division of the party will make a collection of marine life. The party will then return to Honolulu, possibly stopping at Fanning Island for a short time. Mr. Coultas will then go to Kauai and Laysan Islands to collect material for two additional oceanic bird exhibits, while Dr. Miner and his party will return to San Francisco by steamship and reach New York in December.

During the entire trip special attention will be given to the collection of oceanic marine invertebrates, with particular emphasis on the forms found in comparatively shallow waters and the life of the sea surface. It is expected that many valuable additions to the scientific collections of the museum will be made in this way.

The yacht *Zaca,* which has been put at the disposal of the American Museum for this expedition by Templeton Crocker, has already made four scientific trips, one of which was also in the interests of the American Museum—the 1934 expedition to the Tuamotus, Easter and Pitcairn islands. She is a two-masted gaffrigged schooner with topsails, with the general lines of a Newfoundland Bank fishing-schooner, 118 feet over all, 96 feet water line, 23 feet beam, 14 feet draught, gross tonnage of 84 and is equipped with two Hill Diesel engines, each developing 120 horse power. She is very strongly built, for any ocean travel in any weather, a cruising yacht well adapted for both comfort and utility, with a well-trained crew of twelve men.

LECTURES AT THE UNIVERSITY OF OREGON

The comparative isolation of the Pacific Northwest from the great centers of population and their accompanying large universities and research institutions makes the problem of securing speakers for scientific meetings a difficult one. During the past academic year the University of Oregon was unusually successful in overcoming this difficulty, largely because of the efforts of the local Sigma Xi chapter and the science faculty.

Dr. C. G. S. de Villiers, dean of sciences, University of Stellenbosch, South Africa, while a guest of the university under the auspices of the Carnegie Foundation for the Promotion of Peace, provided many illuminating lectures and discussions, including "New Theories of Evolution."

Jiro Harada, commissioner of the Imperial Household Museum at Tokyo, while guest of the university as professor of oriental art, gave an address entitled "The Pre-history of Japan."

Dr. Ralph Chaney, head of the department of paleontology, University of California, invited by Sigma Xi, spoke on "Ancient Forests of Oregon," and (at a student assembly) on "A Scientist's Adventures in Mongolia and Central America."

Dr. Robert H. Lowie, professor of anthropology, University of California, delivered the address at the annual joint Phi Beta Kappa-Sigma Xi initiation banquet. His subject was "Cultural Anthropology."

While visiting the Sigma Xi chapter at the university and the Sigma Xi club at Oregon State Agricultural College (Corvallis, Ore.), Dr. Armin O. Leuschner, professor of astronomy in the University of California, gave an address at Corvallis, entitled "Long Range Prediction of the Orbits of the Minor Planets."

Other Sigma Xi lectures were: "Some Experiments in the Attempt to Understand Inefficient Reading," Professor H. R. Crosland (psychology), retiring president of Sigma Xi; "Ultimate Theories of Matter," Professor A. E. Caswell (physics); "Philosophy and Science," Professor H. G. Townsend (philosophy); and "Forensic Applications of Blood Groupings," Dr. S. B. Osgood (medicine).

In addition, the science faculty sponsored a series of popular science lectures which were very well attended by townspeople as well as faculty and students of the university. Most of the lectures were given by resident members of the faculty. The program follows:

"Scenic Resources of Oregon," Professor W. D. Smith (geology); "The Universe around Us," Professor A. E. Caswell (physics); "Problems of South Africa," Dean C. G. S. de Villiers, Stellenbosch University, South Africa; "Some Elements of Small Arms Ballistics," Major R. H. Back (R. O. T. C.); "Rambles of a Naturalist in Oregon Winter Time," Professor F. P. Sipe (botany); "Daylight Ghosts or Fantasms of Everyday Life," Professor H. R. Crosland (psychology); "Natural History of Oregon Birds and Mammals," Professor R. R. Huestis (zoology); "Liquid Air," Elliott James (demonstrator at Century of Progress Exposition).

Finally, the university community had the pleasure of having an illustrated lecture on Alaska by Father Hubbard, the Glacier priest. This lecture was sponsored by the Active Club of Eugene, the proceeds going to the support of a summer camp for underprivileged boys.

A. H. Kunz

PHYSICS SYMPOSIUM AT CORNELL UNIVERSITY

Nuclear physics was the subject of the discussions at the second Cornell University physics symposium. The meetings were held in Ithaca on July 2, 3 and 4, and the attendance was about a hundred and thirty. At the first meeting on Thursday morning, July 2, Pro-

fessor R. C. Gibbs extended cordial greetings on behalf of the Cornell group and announced the plans for the meetings. At this session Professor L. A. DuBridge, of the University of Rochester, presided, and papers were presented on the determination of atomic masses. Professor K. T. Bainbridge, of Harvard University, discussed the most recent work on the determination of atomic masses with a mass spectrograph, and Professor M. S. Livingston, of Cornell University, presented a paper, which had been prepared in collaboration with Professor H. A. Bethe, also of Cornell, on the determination of atomic masses from nuclear disintegrations. At the afternoon session, Dr. G. L. Locher, of the Bartol Foundation, presided, and reports were presented by Dr. H. R. Crane, of the University of Michigan, on gamma rays from nuclear transmutations and by Dr. J. J. Livingood, of the University of California, on nuclear disintegrations and radioactivity observed with deuteron bombardment.

At the Friday morning session, Professor E. U. Condon, of Princeton University, presided and papers were presented by Professors H. A. Bethe, of Cornell University, and G. Breit, of the University of Wisconsin. Professor Bethe discussed the information now known about the forces between nuclear particles and the structure of the lighter nuclei. Professor Breit discussed the theory of proton-proton scattering. Professor G. B. Pegram, of Columbia University, presided at the afternoon session, which was devoted to the discussion of experiments with neutrons by Professors E. Fermi and F. Rasetti, of the University of Rome. Professor Fermi presented the results of some of the recent experiments performed in Rome, and also the interpretation of these results. Professor Rasetti discussed experiments carried out in this country, largely at Columbia University, where he has been working during the past year.

Professor Fermi presided at the final session of the symposium on Saturday morning. Papers were presented by Dr. T. W. Bonner, of the California Institute of Technology, and by Dr. L. R. Hafstad, of the Carnegie Institution of Washington. Dr. Bonner discussed the energy relations of the disintegrations observed when light nuclei are bombarded with protons and deuterons. Dr. Hafstad presented the results of the work recently done at Washington on the proton-proton scattering.

In addition to the regular sessions there were informal discussion groups devoted to "Beta-ray spectra," "Nuclear moments" and "Cyclotron technique" as well as a meeting of those particularly interested in nuclear theory.

THE THIRD WORLD POWER CONFERENCE

THE third World Power Conference and the concurrent second Congress on Large Dams will open in Washington in Constitution Hall on the evening of September 7, when Secretary of State Cordell Hull will deliver the main address.

Dr. William F. Durand, of Stanford University, who is acting as general chairman, will preside and will address the delegates in four languages—English, French, German and Spanish. Representatives of Argentina, Mexico and Canada will also speak as joint hosts. The representatives of the following countries will then respond to the welcome: Germany, Poland, Belgium, Denmark, Roumania and Russia. Conference sessions will open at 2:00 P. M. on Monday with a discussion of the coal and oil industries.

On Tuesday afternoon the group will travel to Mt. Vernon for a reception and tea. On Wednesday evening a dinner will be held at the Congressional Country Club for the International Executive Council and the International Second Congress on Large Dams, with Director O. C. Merrill acting as host.

Other speakers on this occasion will be Sir Harold Hartley, international chairman of the conference; M. Gustav Mercier, international chairman of the Second Congress on Large Dams, and Chairman Frank McNinch, of the Federal Power Commission, and representatives of China, Lithuania, Ireland, Uruguay, Greece and others.

On Thursday evening a banquet will be held in the main hall of the Union Station. On this occasion the president of the National Academy of Sciences will pay tribute to the memory of the pioneers of science who created the foundations on which rests the structure of modern power development. Secretary of the Interior Harold L. Ickes will speak next, being followed by representatives of France, South Africa and a South American nation. Floyd L. Carlisle, chairman of the board of the Consolidated Edison Company of New York, will speak next, representing the utility industry, joint sponsors of the conference. Speakers representing Great Britain, Austria and Sweden will follow Mr. Carlisle. Owen D. Young, chairman of the board of the General Electric Company, will be the next speaker, representing the electrical manufacturing group, which is also supporting the conference. He will be followed by speakers representing Japan, Switzerland and Cuba.

President Roosevelt will speak at a general meeting on Friday afternoon, September 11. During his speech he will push a button starting the generation of power and the flow of water through the needle valves at Boulder Dam. The President's speech will be broadcast nationally as will the activity at the dam.

The ceremonies at Boulder Dam, including the sounds of the first generation of power there, will be brought back by radio to the Auditorium and broadcast there over the amplifying system.

Also scheduled to speak at this special session are Lewis Mumford, the writer, on "Power and Culture"; Arthur Surveyer, eminent Canadian authority, on "Power and Social Progress," and Senor Joa Marques dos Reis, Brazilian Cabinet Minister, on "Power and the State."

The closing session will be held on Saturday afternoon when an impressive ceremony will mark the transfer of the presidency of the World Power Conference from the hands of a German to a representative of the hosts, an American. Dr. Julius Dorpmueller, head of the Reich Railroads, has served as president of the conference since the death of Oskar von Miller, who was elected at the 1930 meeting in Berlin.

THE HARVARD TERCENTENARY CONFERENCE OF ARTS AND SCIENCES

An article giving full details in regard to arrangements for the Harvard Tercentenary Conference of Arts and Sciences appeared in the issue of Science for April 3.

The conference began on August 31, and continues until September 12. The program of papers in the biological sciences to be given next week is as follows:

Tuesday, September 8

"The Fundamental Nature of the Respiratory Rhythm." Sir Joseph Barcroft, professor of physiology, University of Cambridge.

"The Influence of Chemical Thought on Biology." Sir Frederick Gowland Hopkins, professor of biochemistry, University of Cambridge.

"Diabetes as a Disturbance of Endocrine Equilibrium." Bernardo Alberto Houssay, professor of physiology, University of Buenos Aires.

"Insect Polyembryony and its General Biological Aspects." Filippo Silvestri, professor of general and agricultural zoology, Regia Scuola Superiore di Agricultura, Portici.

"Plants and Civilizations." Elmer Drew Merrill, professor of botany, Harvard University (late director of the New York Botanical Garden. Invited, before his appointment in Harvard University, to take part in the Tercentenary Conference.)

"The Biology of Whales." Johan Hjort, professor of marine biology, University of Oslo.

Wednesday, September 9

"Relations of Symmetry in the Developing Embryo." Ross Granville Harrison, professor of biology, Yale University.

"Über die Wirkungsweise des Organisators." Hans Spemann, professor of zoology, University of Freiburg.

Thursday, September 10

"Serological and Allergic Reactions with Simple Chemical Compounds." Karl Landsteiner, member of the Rockefeller Institute for Medical Research.

"The Trend of Prevention, Therapeutics and Epidemiology of Dysentery since the Discovery of its Causative Organism." Kiyoshi Shiga, Kitasato Institute, Tokyo.

"The Use of Isotopes as Indicators in Biological Research." August Krogh, professor of zoophysiology, University of Copenhagen.

"Formation of Enzymes." John Howard Northrop, member of the Rockefeller Institute for Medical Research.

"Protein Molecules." The Svedberg, professor of physical chemistry, University of Upsala.

SCIENTIFIC NOTES AND NEWS

The Hayden Memorial Geological Award of the Academy of Natural Sciences of Philadelphia has been presented this year to Dr. Andrew Cowper Lawson, professor of geology emeritus at the University of California, for his "fundamental geological studies concerning . . . the foundation of the North American continent, . . . significant studies of the classification and internal structures of rocks, . . . of the mechanisms of eruptions of lava, the origin of the Sierra Nevada and Coast Range, seismic phenomena of the Pacific Coast region, and the topographic evolution of arid regions." The award consists of a gold medal endowed in 1888 by Mrs. Hayden as a memorial to Dr. Ferdinand V. Hayden.

Andrew W. Mellon, formerly Secretary of the Treasury, will receive the Pittsburgh award for outstanding service to chemistry at the ninety-second meeting of the American Chemical Society in Pittsburgh on September 9. The award will be shared posthumously by his brother, the late Richard B. Mellon. The honor was voted in recognition and appreciation of their work in connection with the Mellon Institute of Industrial Research.

Dr. J. Frank Daniel, chairman of the department of zoology at the University of California, has been created a knight of the Legion of Honor by the Government of France. Last year Dr. Daniel represented the university and the California Academy of Science at the celebration of the three hundredth anniversary of the founding of the National Museum of Natural History in Paris.

Dr. Edward Bartow, of the State University of

Iowa, president of the American Chemical Society, has been made an honorary member of the American Water Works Association.

DR. PASTEUR VALLERY-RADOT, a grandson of Pasteur, associate professor in the University of Paris Medical School and attending physician to Paris hospitals, has been elected a fellow of the Paris Academy of Medicine.

SIR ERNEST GRAHAM-LITTLE, M.P., of the University of London, has been elected a member, *honoris causa,* of the French Dermatological Society.

HENRY L. COLES has resigned as head of the department of chemical engineering at the University of Detroit to accept a similar position at the University of Colorado.

DR. ARNOLD P. HOELSCHER, connected with the division of metallurgy of the department of chemistry at the University of Iowa for the last four years, has joined the faculty of chemical engineering at Purdue University as assistant professor of metallurgy.

AT the University of Michigan J. Henry Rushton, formerly of the Drexel Institute, Philadelphia, has been appointed assistant professor of chemical engineering, and C. A. Siebert, of Wayne University, has been appointed assistant professor of metallurgical engineering.

DR. WILLOUGHBY M. CADY, of Clark University, has been appointed instructor in physics at Cornell University.

M. LOUIS-ALFRED PIEDRO GERMAN, professor of malacology at the National Museum of Natural History, Paris, has been elected for a period of five years director of the museum.

DR. ETIENNE BURNET, known for his work on undulant fever, leprosy, tuberculosis and other work in connection with the Health Section of the League of Nations, has been made director of the Pasteur Institute at Tunis, in succession to the late Dr. Charles Nicolle.

CHARLES S. ELTON, director of the Bureau of Animal Population in the department of zoology and comparative anatomy of the University of Oxford, has been elected senior research fellow at Corpus Christi College.

DR. JOHN HAROLD CROSSLEY THOMPSON has been elected to a fellowship and lectureship in mathematics at Wadham College, University of Oxford.

DR. CLIFFORD G. PARSONS, at present holding the appointment of resident medical officer at the Birmingham, England, United Hospital, has been appointed Walter Myers traveling student for one year from February 1, 1937, to undertake research on "Anemia in Relation to Diseases of the Cardiovascular System" at New York and at Baltimore or Boston.

Nature states that Dr. E. C. Bullard has been appointed Smithson research fellow of the Royal Society as from January 1. Dr. Bullard proposes to continue his present work on the development of methods of measurement and their application to geological problems in the department of geodesy and geophysics of the University of Cambridge.

STEPHEN N. WYCKOFF, who has for thirteen years been in charge of the western office of the Blister Rust Control of the Bureau of Entomology and Plant Quarantine, Spokane, Wash., has been made director of the Northern Rocky Mountain Forest and Range Experiment Station of the Forest Service, with headquarters at Missoula, Mont. He succeeds Lyle F. Watts, who recently became regional forester for the Central States region.

HAROLD R. HARMAN, formerly in charge of battery research at the Eagle-Picher Lead Company at Joplin, Mo., has been appointed chief chemist of the research laboratory.

DR. CHARLES L. WILLIAMS, senior surgeon, U. S. Public Health Service, and officer in charge of the Algiers Quarantine Station, New Orleans, has been promoted to assistant surgeon in the service in charge of the foreign quarantine division for the United States.

DR. WILLIAM BURNS, director of agriculture, Bombay, has been appointed agricultural expert with the British Imperial Council of Agricultural Research in place of the late Dr. F. J. F. Shaw.

THE late Sir Henry Wellcome in his will has appointed Geo. E. Pearson governing director for life of the Wellcome Foundation Ltd. Mr. Pearson has been deputy governing director of the foundation since its formation in 1924.

DR. A. S. PEARSE, of Duke University, has returned from Yucatan, where he spent three months in studying cave animals.

DR. ALBERT W. C. T. HERRE, curator of the Zoological Museum of Stanford University, left on August 27 for the Chekiang Provincial Fisheries Experiment Station at Tinghai, Chusan Islands, China, where he will spend six weeks or two months. Hong Kong and Canton will be visited next, followed by a couple of months in the Philippines. An attempt will be made to collect fresh-water fishes in the northeast quarter of British North Borneo. Two months will be spent in the Malay Peninsula, working on the fresh-water

fishes in collaboration with Raffles Museum, of Singapore.

Dr. Thomas L. Patterson, professor of physiology at Wayne University, Detroit, is serving as acting professor of physiology at the Hopkins Marine Station of Stanford University during the summer quarter of 1936, where he is conducting research investigations on the gastric motor mechanism of fishes. He is also giving a course of evening lectures on "The Comparative Physiology of the Mechanics of the Gastrointestinal Tract of Invertebrate and Vertebrate Animals."

The extension division of the University of California announces a series of ten lectures on "Light and the Application of its Properties through the Microscope, the Spectroscope and other Optical Instruments." The lectures will be given by Haller Belt and George S. Prugh, respectively president and vice-president of the Bausch and Lomb Optical Company of California. They will be given on Friday evenings, beginning on September 11.

The fourth International Grassland Congress will be held next year at Aberystwyth, Wales, from July 15 to 18.

The Geographical Conference at Sofia was opened on August 16 by Professor Mishaikoff, the Minister of Education. Some 420 geographers and ethnographers of all Slav countries and visitors from France, Finland, Germany and Austria attended.

The first annual International Horticultural Exposition will be held in the International Amphitheater at the Chicago Stock Yards, from September 12 to 20. Many educational features will be installed with the cooperation of the U. S. Department of Agriculture, the state departments of agriculture, some thirty agricultural colleges and experiment stations, and a number of national horticultural societies. A corps of practical gardeners and experts upon all phases of horticulture will be on duty to answer questions for visitors, give advice on individual gardening problems and conduct demonstrations on proper methods to employ in various gardening practices.

A Bureau of Biological Research has been organized at Rutgers University to promote biological research through the cooperative efforts of its members. Eleven research projects have been approved for the academic year 1936–37, and work on these investigations is in progress.

Nature states that the curators of the university chest of the University of Oxford have been authorized to receive from the Rockefeller Foundation a sum not exceeding £1,600 annually for five years from October 1, 1936, for researches in the Dyson Perrins Laboratory on the synthesis of proteins.

A plan to build a new central technical college at Birmingham, England, costing over £1,000,000 when completed, has been approved by the Education Committee. The building cost is estimated at £560,000, plus £200,000 for the site and compensation, and in addition professional fees, plant, equipment and furnishing are estimated at over another £200,000. The building will incorporate the present technical college departments, the commercial college and various sections of the School of Art, together with a domestic science department, gymnasia, refectory and library.

The botanical department of the Johns Hopkins University has completed the seventh of the expeditions to the West Indies conducted by Duncan S. Johnson. The party spent two months in Jamaica at work on the coral reefs and coastal plains, and on the rain forests of the Blue Mountains. The botanists of the group included Professors M. A. Chrysler, R. E. Cleland and William Seifriz and Messrs. B. E. Goldberg, H. N. Stoudt and R. N. Webster. Besides collecting herbarium and alcoholic research material, they investigated the reproductive structures of certain marine algae, the vegetative propagation of ferns and the development and anatomy of Cycadaceae, Araceae, Batidaceae, Lauraceae and Myrtaceae. They also explored a biologically unknown valley north of Blue Mt. Peak. The zoologists in the party, Drs. W. G. Lynn, J. B. Buck and C. B. Davidheiser, were engaged in the study of lepidoptera, certain tree frogs with no tadpole stage in their development and the period of luminescence of various fireflies.

Dr. A. C. Boyle, Jr., formerly chief geologist of the Union Pacific Railway System, has been appointed acting custodian of Dinosaur National Monument, Jensen, Utah. He is also project superintendent and geological engineer in charge of the operations at the quarry site. The National Park Service, Washington, D. C., is sponsoring the development of the monument, and the work is being done by 100 men furnished by the WPA and living in a camp near the site of excavations. Dr. Barnum Brown, curator of fossil reptiles at the American Museum of Natural History, N. Y., is directing the actual work. A correspondent writes: "The plan is to work the bones out in bas-relief on a solid wall of indurated sandstone which has a regional dip of about 65 degrees. When finished the exhibit promises to be the finest natural portrayal of dinosaur remains yet discovered. This quarry is famous for the skeletons and parts of skeletons which were quarried during the time Dr. Earl Douglass operated the quarry. From present operations it appears that thousands of bones will be encountered in the work of excavation."

The American Institute of Mining and Metallurgical Engineers in cooperation with the Metal Prod-

ucts Exhibits, Inc., has assembled an exhibit which shows the metallic elements present in the earth's crust, their availability, the locations of commercial sources and the flow of metals and minerals in world trade. Genuine ores, metals and typical fabricated metal products, including specimens and displays supplied by state and federal agencies as well as the major metal producing companies, are included. The exposition opened on August 17 and will close on October 17 at the Metal Products Exhibits in the International Building at Rockefeller Center. It is open every weekday from 10 A. M. to 6 P. M. except Saturday, when the closing hour is 3 P. M. Admission is free.

DISCUSSION

THE EIGHTIETH ANNIVERSARY OF PROFESSOR S. N. WINOGRADSKY

PROFESSOR SERGEI NIKOLAEVITCH WINOGRADSKY, who will reach the venerable age of eighty on September 1, 1936, may be considered by common consent as the dean of soil microbiologists. In the words of his prominent student, Omeliansky, whom he has survived, Russia produced two outstanding bacteriologists, I. Metchnikov in the medical field and S. N. Winogradsky in the non-medical.

Born of a rich and aristocratic family in the region of the Ukraine, Winogradsky was educated in the Universities of Kiev and St. Petersburg. His first scientific interests were directed to the morphology and physiology of bacteria. Finding that the Russian institutions offered only limited facilities for conducting investigations in this field, he left for western Europe, but he did not become expatriated, as was the case of Metchnikov. Winogradsky spent several years in the laboratory of De Bary in Strasbourg and, when the latter died, he settled at the University of Zürich. At these two institutions, he made his epoch-making contributions to the knowledge of autotrophic bacteria. First, the sulfur-oxidizing organisms, the iron bacteria and finally the nitrifying bacteria. The principles laid down by Winogradsky concerning the metabolism of these highly interesting and important groups of microorganisms served as the foundation for the numerous investigations that were to follow. Winogradsky not only developed but discovered this field of microbiology.

In 1891, Winogradsky, while still in Zürich, received a tempting invitation from Pasteur to come to Paris and organize a division of soil microbiology at the Pasteur Institute. He refused, in order to accept another invitation extended to him simultaneously from his home land, to organize a division of general microbiology at the newly established Institute of Experimental Medicine in St. Petersburg. He soon became the first editor of the *Archives of Biological Sciences* and was later made director of the institute. His scientific interest was now turned to the study of the nature and physiology of non-symbiotic nitrogen-fixing bacteria, and later of pectin-decomposing bacteria. Executive duties soon interrupted his scientific work, leading to his final retirement both from active research and from his executive position at the institute, in 1905. Some of his investigations were continued by his capable assistant, Omeliansky, who later took his place at the institute.

Winogradsky retired to his estate in the Podol to engage in practical agriculture. Here, surrounded by his family, he would have spent the remaining years in the manner of a Russian landlord, so well described by the novelists Turgeniev and Tolstoi. However, fate willed it otherwise. The Russian revolution resulted in the complete economic destruction of the class of landowners. Winogradsky, among many others, was forced to leave his native country and seek refuge in foreign lands. In 1921 he found himself in Yugoslavia, without any means of support. Although he was immediately appointed professor at the University of Belgrade, he had little opportunity for pursuing scientific work. Upon learning of his fate, the Pasteur Institute renewed again the invitation extended to him 30 years previously, which he now accepted. In 1922 he established a division of soil microbiology at the Pasteur Institute. A small estate, located at Brie-Comte-Robert, some 40 kilometers outside of Paris, was placed at his disposal.

In his new laboratory, Winogradsky devoted himself primarily to the study of the microbiological population of the soil. In rapid succession, he carried out a series of brilliant investigations on methods of studying microorganisms in the soil, on the nature of cellulose decomposing bacteria, nitrogen-fixing bacteria and nitrifying bacteria. His annual critical reviews dealing with the subject of soil microbiology in the *Bulletin* of the Pasteur Institute and a series of 8 memoirs published in the *Annals* of the institute and dealing with his own investigations, attracted considerable attention and aroused new interest in the science.

At the age of 80, Winogradsky is still engaged in research work. He has few assistants, his daughter, Helene, being his only collaborator. His mind is as active, vigorous and critical as ever. He is anxious

to devote all his available time to his investigations, since he fully recognizes how much of the field will still be left untouched after he is gone. Among the quiet surroundings of the country estate, outside of Paris, enclosed by the traditional stone fence, there lives the sage of soil microbiology, where pilgrims from many countries come to pay their respects.

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A WHALE SHARK OFF BIMINI, BAHAMAS

In January, 1935, I published in the *Proceedings of the Zoological Society of London* an extensive paper on "The Distribution of the Whale Shark, *Rhineodon typus*." In this I listed 76 recorded specimens as of December 31, 1934. On page 882 of this I wrote:

> For some time newspaper accounts have been sent in to me purporting to relate encounters with the whale shark in the Gulf Stream between Miami, Florida, and the Bahamas. Efforts have been made to get definite facts about these reputed occurrences, but so far in vain. There is no reason why the shark should not be found there.

I have spent much time and effort in the fruitless endeavor to verify these accounts, and while persuaded of their validity, I have not been able to get any photographs nor have I been able to get in touch with any man of scientific training who had seen one of these great sharks in this region. Some of these reports spoke of large spotted sharks, but the identification from this angle is complicated by the presence in these waters of the spotted tiger or leopard shark, which grows to a considerable size. They are said to reach 18 feet, and, while my largest (taken at Key West) only reached 12.5 feet, I have no doubt that an occasional one does reach 16 or 18 feet.

Such then was the situation when on July 9, 1936, I had a call from Dr. G. W. Phelps, a practicing physician of New York City and member of the American Museum. Dr. Phelps has long known of the whale shark and of my interest in it. So he took the trouble to come to my office and to communicate the data which form the basis of this note.

On June 15, 1936, while leaving Bimini, Bahamas, a very large shark was seen swimming over the white coral sand not far away. When the boat came closer, Dr. Phelps at once recognized it as a whale shark, pictures of which he had seen in my articles in *Natural History*. It was described to me as having a square blunt head with a terminal mouth. On the back there were visible at least three longitudinal ridges, and running vertically across these were faint light buff vertical bars. The ridges and bars crossing at right angles gave the side of the fish a checker-board-like appearance, with large buff-colored spots in the squares.

This description surely makes out this fish as *Rhineodon typus*. It was a large specimen. The boat followed it around for about an hour, but the fish showed no fear of it whatever. The boat was 36 feet long and by getting it as nearly alongside the shark as possible, the length of the fish was estimated as fully as great as that of the boat.

The whale shark has long been known from Florida waters. In 1902, B. A. Bean recorded one which came ashore that year at Ormond Beach. Others have been recorded by the writer: one in 1913 at Knight's Key; another in 1919 from near Cape Sable in the Bay of Florida; the third in 1923 at Marathon; the fourth near Miami in 1932. Then I have an unverified account that two or three years ago a small school of whale sharks had been seen by a bridge tender on the Florida East Coast Railway, making a passage in the deep channel under his bridge between two keys.

From the Cuba side of the Straits of Florida, Gudger and Hoffmann in 1928 and in 1930 recorded two specimens; one from each side of the mouth of Havana harbor. Then in 1936, I made known the capture of a third fish from the very mouth of Havana harbor. Furthermore, Dr. Hoffmann has heard of a spotted shark, off Cójimar Village, five miles east of Havana, so well known and so huge that it was locally known as "El Elephante." But it has remained for the Cuban ichthyologist, Luis Howell Rivero, to record in February, 1936, the presence of a small unmounted skin (6 feet long—the smallest known specimen) in the Instituto of Havana. Rivero also reveals that Poey in 1876 listed as *Chetorhinus maximus* a large shark in Cuban waters. But his mention that the fish had white spots on a dark background like a "checker-board" identified it beyond doubt as *Rhineodon typus*.

From these records it is seen that in what may be properly called the Straits of Florida, four whale sharks have been recorded from Florida waters, one from Bahamas, and five from Cuba—a total of 10 specimens. As this great fish becomes better known and better differentiated from the tiger shark, it may be expected that other specimens will be definitely reported from these waters.

E. W. Gudger

American Museum of
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MEAT DIET: BLOOD AS AN ANTI-SCORBUTIC FACTOR

With relation to the prevention and cure of scurvy, there are well-known discrepancies between the results

of those who experiment in feeding animals and those who get their information from observing "native" peoples. Specifically, lean muscle has been reported as of little or no anti-scorbutic value with experimental animals, though it appears to be a sufficient anti-scorbutic when used by Eskimos or polar explorers.

The statement is frequently seen that carnivorous man would suffer from scurvy on a diet of meat, except that he is protected by eating such organs as the liver which are rich in Vitamin C. A variant of the statement is that you can remain in good health on a meat diet, provided you eat the whole animal or practically the whole of it.

One of the conclusions which most of those concerned drew from the experiment where two of us lived exclusively on meat for a year, under the supervision of the Russell Sage Institute of Pathology,[1] was that you do not need to eat the whole animal, or anything approximating that, in order to be protected from deficiency diseases.

The explanation has been advanced that if a guinea pig develops scurvy on lean meat and a man does not it is because men differ in some ways from guinea pigs. Another point seems worth raising.

The flesh food of most or all carnivorous people, such as uncivilized Eskimos or northern explorers who live by hunting, contains a great deal of blood. But (perhaps deriving our method from Semitic practice) our butchers are careful to bleed animals. A given weight of animal food as consumed by an Eskimo therefore contains a considerable proportion of an ingredient nearly absent from butcher's meat or from meat as obtained by farm butchering.

The all-meat diet which protected Karsten Andersen and me from scurvy for a year (1928–29) in New York had occasional meals of liver and bacon. But the diet which brought a rapid recovery from advanced scurvy to Lorne Knight and Harold Noice in 1917, as described on pages 615–619 of my book, "The Friendly Arctic" (New York, 1921), contained no liver. There were absent from it, too, most of those organs which are usually cited by dietitians in explaining how it is that carnivorous man does not have scurvy. The things eaten were chiefly lean muscle.

It would, then, seem worth considering whether the discrepancies between human and animal experimentation with regard to the anti-scorbutic value of flesh foods may not be due to the presence of considerable quantities of blood in one diet and to the comparative absence of it from the other.

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NEW YORK, N. Y.

[1] Clarence W. Lieb, M.D., *Jour. of the American Medical Association*, July 6, 1929.

THE INCIDENCE OF COLOR-BLINDNESS AMONG JEWISH MALES

THE writer gave the Ishihara color-blindness test to 529 New York Jewish boys and men, 474 of whom were students in New York University. No subject was included unless his parents and all four grandparents were Jewish.

Each subject was tested individually, one eye at a time, under good light. If he misread or was unable to see the numbers on two or more of the ten plates normally read by people with complete color sense the subject was classed as color-blind or color-weak.

Forty subjects, or 7.56 per cent. of the total number tested, were color-blind or color-weak. Of this number, three were unable to see a single number beyond the first and may be considered totally color-blind. Eighteen others were so defective that they misread every plate beyond the first. The other 19 subjects made errors on from three to nine plates. None of the 40 made fewer than three errors. In common with other investigators we found green-blindness to be more prevalent than red-blindness. Eleven *Ss* were completely green-blind but not completely red-blind, while two were only red-blind.

For the most part the *Ss* were equally blind with their two eyes. However, we found three cases of differential blindness. One subject had normal vision with one eye, but incomplete color-vision with the other, as shown by the fact that he misread three plates with this eye. Two *Ss* could read no number beyond the initial one with one eye, but one of these students was only red-green blind in the other eye, while the second was only green-blind in the other eye.

About one half of the subjects' parents or grandparents were born in Russia, the rest being largely of Austrian, Polish, German and Hungarian stock. We considered the records of the Jews of Russian descent separately and found 8.1 per cent. of them to be color-blind.

In conclusion, our experimental results do not bear out Garth's[1] finding that Jewish males are different from other white males in color sensitivity.[2]

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SYMBOLS FOR THE ARTIFICIALLY RADIOACTIVE ELEMENTS

IN the issue of SCIENCE of August 21 (84: 183, 1936) Gerald M. Petty proposes to designate artificial

[1] T. R. Garth, SCIENCE, 71: 462, 1930; 77: 333–334, 1933.

[2] For further reference, see F. Clements, SCIENCE, 72: 203–204, 1930; K. B. M. Crooks, SCIENCE, 80: 269, 1934; L. G. Kilborn and Y. T. Beh, SCIENCE, 79: 34, 1934; W. Miles, *Jour. Gen. Psychol.*, 2: 535–543, 1929.

lioactive elements by prefixing "ra-" before the ordi- ry symbol. Mr. Petty seems to base this on the pposition that Ra is the correct prefix for the symbol the natural radioactive elements such as Radio- prium, etc.

In order to avoid confusion, I should like to point t that the best usage has never employed Ra in this y as a prefix for "radio" but Rd, as for example, Th, Rd Ac, etc. All the advantages of Mr. Petty's pposal may be retained and uniformity conserved if we continue to use Rd for the natural radioactive elements and use "rd-" for the artificial ones.

In case there is more than one active isotope of an element, we shall still have to give the mass number as a superfix. In case of isobaric isotopes (for the existence of which additional evidence is accumulating), we shall also have to indicate their life periods in parenthesis or adopt some other convention.

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SPECIAL ARTICLES

HE TRANSMISSIBLE AGENT IN THE ROUS CHICKEN SARCOMA NO. I[1]

DURING the past decade an impressive amount of idence has been accumulated associating the lipids, d more particularly the sterols, with growth of sue, both abnormal and physiological.[2] The chem- l relationship between the estrogenic hormones, ny carcinogenic substances and cholesterol has been ported and reviewed by a large number of workers. hile this investigation was in progress, Claude ported the partial purification of the Rous sarcoma rate. A large proportion of the protein and car- hydrate was removed by indirect means, leaving an ive fraction which was largely lipid in nature. The d fraction was separated more completely by use acetone, alcohol and ether, but no mention is made its activity.[3]

The methods applied in this laboratory were aimed ectly at isolation of the lipids, the usual chemical cedures being altered according to the known ilties of the agent, which are primarily those of rmolability and spontaneous oxidation. The first cedures yielded a product less active than one ained by subsequent modifications but is worthy note because of the additional information regard- solvents which can be utilized in the study of the ive substance.

Between 200 and 400 grams of fresh tumor tissue, ained by routine transmission of the Rous chicken coma in Rhode Island Red chickens, was ground a meat grinder and shaken from three quarters to e hour in an equal quantity of acetone. The acetone ract was separated by centrifugation and filtered. It was then concentrated *in vacuo,* under nitrogen, at 37° C. until only the watery residue remained, and injected immediately into chickens as the first acetone fraction. The partially dehydrated tumor was ground in a mortar with a second portion of acetone and similarly shaken, centrifuged and filtered clear. This, after evaporation of the solvent, was injected as the second acetone fraction. At times the first and second acetone fractions were combined and part injected as the combined acetone fraction. The remainder was re-extracted with benzene or, at a later date, carbon tetrachloride by shaking with several changes of the specific solvent. Meanwhile the acetone-treated tumor was extracted for three to four hours in a Soxhlet in partial vacuum at approximately 37° C. with either benzene or carbon tetrachloride. This was combined with the benzene or carbon tetrachloride extract of the acetone fraction, filtered clear and the solvent removed in vacuo as above. The residue was dissolved in benzoinated lard at 37° C. or suspended in saline and injected into the breast of chickens. Further details of this and subsequent procedures, as well as analytical studies carried out on these fractions will be described later *in extenso.*

Tumors identical with the Rous chicken sarcoma in morphology, metastatic habits and ease of transmission were obtained by injection of the first and the combined acetone fractions. The animals were given repeated inoculations at weekly intervals after the custom of those working with the synthetic carcinogenic substances. The earliest tumors to appear followed three injections. The majority developed tumors only after an interval of three to four months. The second acetone fraction and the benzene or carbon tetrachloride extract were unsuccessful when injected alone. The residue of the tumor after having been dried and in good part freed of the lipids did not produce tumors.

Feeling that the specific cancerogenic substance might still be present in the more purified benzene

[1] From the Department of Pathology, College of Phy- ians and Surgeons, Columbia University, New York y. This investigation has been aided by a grant from Josiah Macy, Jr., Foundation.

[2] L. Loeb, *Jour. Am. Med. Asn.,* 104: 1597, 1935; Lacassagne, *Am. Jour. Cancer,* 27: 217, 1936; D. A. cFayden and E. Sturm, SCIENCE, 84: 49, 1936; F. inl and E. Chrobok, *Ztschr. f. Immunitäts.,* 86: 274, 5.

[3] A. Claude, *Jour. Exp. Med.,* 61: 27 and 41, 1935.

extract but in a form too readily inactivated in the body, the extract was prepared as above and treated as follows: The breast of a normal chicken was inoculated repeatedly with kieselguhr, which is known to stimulate a mononuclear and giant cell response. After two days the yellow granular exudate thus produced, together with a small amount of muscle, was scraped out and a 10 per cent. suspension prepared by grinding with sand in normal saline. The suspension was centrifuged at high speed and the supernatant fluid separated. The benzene extract of the tumor which had been evaporated to a sticky mass was then suspended in this saline extract of normal chicken wandering cells and muscle, incubated one hour under nitrogen at 37° C. and injected immediately. Large tumors with many metastases were produced, and these were capable of transmission for an indefinite period. Again repeated inoculations were required.

Subsequent studies were aimed at the isolation of a lipid fraction, by methods less injurious to the active agent. The acetone technique was discarded and the ground tumor tissue was frozen with carbon dioxide snow and desiccated in the Flosdorf-Mudd Lyophile apparatus. The dried material thus prepared shows no loss of activity. Upon removal from the high vacuum apparatus, the dried tumor was immediately extracted with benzene, or, at a later date, with carbon tetrachloride, in a Soxhlet as before. This extract gave negative results if injected alone, but when incubated with a saline extract of chicken muscle prepared as above, produced large tumors more rapidly than those hitherto obtained. This experiment has been repeated on several occasions during the past year, since the procedure was utilized as a control for further studies, and the extract thus prepared has been found capable of producing tumors within two to three weeks following a single injection. Other chickens were given two or three injections. Almost 100 per cent. of the chickens developed tumors, and the majority appeared to be highly malignant.

The residue of dried tumor after extraction with benzene still retained a degree of activity, which was to be expected, since extraction with benzene or carbon tetrachloride is less complete if the tissues have been previously frozen and dried than if acetone is used as the dehydrating agent. The disadvantage of the material waste was more than compensated for by the superior activity of our final fraction.

A series of animals was subjected to a slight modification of procedure. Kieselguhr was inoculated into the breast muscle several times until considerable injury had occurred, and the lipid extract of the tumor was then injected alone. Tumors did not develop, showing that a period of contact with normal tissue extract *in vitro* is necessary for the production tumors.

To test the possibility that the active agent wa contaminant introduced by contact with instrum or glassware used in the routine transplantation the tumor or that a ubiquitous agent existed, cap of acting upon tissues prepared by the inoculatio these lipid fractions, the same procedure was follo using the lipid fraction of normal chicken mu This extract obtained after freezing, drying and traction with carbon tetrachloride failed to prod tumors alone or following incubation with a sa extract of muscle. The same precautions as to t perature and the use of nitrogen were obse throughout the extraction, and the material was jected immediately. Repeated inoculations were gi and the animals kept for an equal period of time.

The lipid extract of the Rous chicken sarcoma 1, then, obtained by use of a specific solvent at temperature under relative anaerobiasis, was cap of transmitting the tumor to chickens when allo contact with chicken tissue extract for a brief pe and inoculated promptly. Tumors did not develo the lipid extract was inoculated alone or into viously injured breast muscle.

JAMES W. JOBLIN
E. E. SPROUL

SOME EFFECTS OF ANDROGENIC SUBSTANCES IN THE RAT[1]

A. THE EFFECT OF MALE HORMONE EXTRACTS ON TESTES OF HYPOPHYSECTOMIZED RATS

WALSH, Cuyler and McCullagh[2] reported that daily administration of extracts of male hormone pared from urine would prevent the usual atrophy the testes that occurs following hypophysectomy the rat. In their experiments injections of male mone (9.0 B.U. per day) were instituted the day a hypophysectomy and continued for three weeks. our knowledge this amazing finding has never confirmed or denied.

We have recently made a series of experiment which a comparison has been made between the eff of castration and hypophysectomy on the reproduc system of male rats (4 to 5 months old). As extension of that study it has seemed desirabl compare the effects of male hormone extracts on reproductive systems of such animals. The m tenance of the various sex accessory structures

[1] These investigations were aided by grants from Anna Fuller Foundation, the Fluid Research Fund Yale University, and the Committee for Research Problems of Sex of the National Research Council the Rockefeller Foundation.

[2] E. L. Walsh, W. K. Cuyler and D. R. McCullagh, *Jour. Physiol.*, 107: 508, 1934.

quite similar in the two conditions, a finding was not surprising.

our earlier experiments we employed a dosage 10 B.U. per day begun the second day after hy-hysectomy and continued for 20 to 21 days. Al-gh the testes of the animals in this series were h smaller than normal, they were definitely larger those of untreated controls. Consequently, it med desirable to continue these experiments with her dosages. Table 1 shows the details of the eriments together with the weights of the testes, averages for each group.

TABLE 1

EFFECT OF MALE HORMONE ON THE TESTES OF HYPOPHYSECTOMIZED MALE RATS

	Average weight	Bird units of male hormone per day	Period of hypophysectomy	Period of treatment	Weight of testes	Sperm motility
	grams		*days*	*days*	*grams*	
1	267	..	Normal	.....	2.432	Excellent
8	208	..	22–23	.....	.517	No sperm
5	197	10	22–23	20–21	.801	Fair
5	189	14	22–23	20–21	1.031	Good
6	199	20	22–23	20–21	1.609	Excellent
2	212	20	40	38	1.586	"
3	195	..	40	.....	.423	No sperm

It will be noted that even in the 20 B.U. group the tes were smaller than normal. However, they were r 3 times as large as those of the untreated controls d were turgid rather than flabby. In histological tion the testes of the treated animals showed semi-ferous tubules that were entirely normal except for decrease in diameter of about 20 per cent. Sperma-genesis was progressing in an apparently normal shion. Sperm motility tests have shown that, while erm were no longer present in the epididymidi of imals hypophysectomized for 22 days, the injected imals had normal sperm motility. As far as we ve been able to detect the degenerative changes that cur in the interstitial cells following hypophysect-y have not been prevented.

Two males were hypophysectomized and injections 20 B.U. daily continued for 38 days. The testes these animals were almost 4 times as large as those the untreated controls (Table 1). One of these ales sired two litters of rats (on the 31st and 39th ys after hypophysectomy), and the other, one litter on the 36th day). This is of particular interest, nce it not only demonstrates that the sperm possessed e capacity for fertilization, but also that male hor-one extracts can restore libido in hypophysectomized imals.

At the present time a group of males have been under treatment with male hormone for six weeks following hypophysectomy. It is intended that they will be so treated for at least 60 days.

Five hypophysectomized males were allowed to remain untreated for 21 to 24 days. At that time one testis, one seminal vesicle and a piece of the prostate were removed and injections of male hormone (20 B.U. daily) were started. Although the sex-accessories were completely repaired, there has been no detectable effect of the male hormone on the testes of these animals. The testes of other animals on a similar schedule, but treated with pituitary extracts, were returned to a normal condition.

Hypophysectomy was complete in all the animals reported here as shown by sections of the sella turcicae and by conditions of regression in the thyroid and adrenal glands. The extracts used in the experiments reported here were highly purified concentrates of male urine. We feel reasonably certain that the possibility of the extracts being contaminated by gonadotropic hormone is exceedingly remote in view of the extraction procedures involved in their preparation. However, experiments to test the action of various synthetic androgenic substances on the testes of hypophysectomized rats are now in progress.

B. THE EFFECT OF SOME SYNTHETIC ANDROGENIC SUBSTANCES ON THE HYPOPHYSIS, MAMMARY GLAND AND UTERUS OF THE SPAYED RAT

Nelson and Gallagher[3] have shown that male hormone preparations obtained from either urine or testes will prevent the occurrence of castration changes in the hypophysis of the rat. Although preparations from which oestrogenic activity had been removed by special procedures were effective it seemed important to investigate the action of synthetic androgenic substances on the hypophyses of castrated rats.

Three substances, *viz.*, androsterone, androstane-diol and androstene-dione, have been injected in spayed virgin rats. Injections have been made at two levels, 0.5 mg and 1.0 mg daily over a 30-day period, beginning the day after ovariectomy. Vaginal smears were taken daily and at the close of the experiment hypophysis, uterus, vagina, mammary gland, adrenal and thyroid have been removed for study.

Androstane-diol and androstene-dione at the 1.0 mg level not only suppressed the castration changes in the hypophysis, but induced the same type of degranulation that has been reported in animals injected with oestrin by Nelson.[4] The 0.5 mg level was not completely effective. Androsterone at the 1.0 mg level almost, but not quite, prevented castration changes.

[3] W. O. Nelson and T. F. Gallagher, *Anat. Rec.*, 64: 129, 1935.

[4] W. O. Nelson, *Proc. Soc. Exp. Biol. and Med.*, 32: 452, 1934.

The mammary glands of the animals on the 1.0 mg level of androstane-diol showed a remarkable proliferation. The development of the ducts was complete and many lobules were present. All acini showed definite secretory activity, but not lactation. Androstene-dione at the 1.0 mg level showed a similar, but less marked effect. Androsterone exerted no detectable influence on the mammary glands.

The uteri of the animals injected with androstane-diol (1.0 mg) showed a marked increase in connective tissue and smooth muscle and were not only much larger than the uteri of castrate controls, but were larger than at the beginning of the experiment. The uteri of the animals that received androstene-dione showed a slight stimulation, while those of the androsterone series were typically castrate.

The vaginal smears of all animals were consistently dioestrus throughout the experiment. In section the vaginas of the animals injected with androstane-diol and androstene-dione showed a slight mucification, while those of the androsterone-treated animals were typically castrate.

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FIXATION OF POTASSIUM IN SOILS[1]

FOR more than half a century the problem of K fixation in soils was investigated and discussed. It was noted that when soluble potassium was added to the soil a large portion of the K became unavailable. With the clarification of the phenomena of base exchange the immobilization of soluble K in soils was considered from the standpoint not only of its insolubility in H_2O, but also in the sense of its being non-replaceable. A number of postulates have been suggested on the mode of fixation. It was natural to suspect the silicates, the primary source of K in soils, as the seat of reactions involving fixation of the K added or released in soils. The one postulate which gained popularity in recent years was that the soluble K in soils reverts to a difficultly soluble complex resembling muscovite. No definite evidence to prove this contention has been advanced. It is perhaps somewhat f[ar]-fetched to think of the formation of silicate miner[als] of K under conditions of temperature and press[ure] prevailing in the soil.

In a series of experiments, conducted by the autho[rs] with artificially prepared silicates of various rati[os] of SiO_2/basoids subjected to alternate wetting a[nd] drying, no fixation of K could be demonstrated. T[he] attention was then directed to other acidoids and [it] was found that the phosphates of a number of cati[on] linkages are capable of fixing K in unavailable or no[n]-replaceable form.

Aluminum and iron phosphates were prepared a[nd] treated with solutions of KCl corresponding to appl[i]cations of 7.6 per cent. of the total dry weight of t[he] respective phosphate complexes. These systems, pr[e]pared in triplicates, were then alternately wetted a[nd] dried five times at 23°, 35° and 70° C. The com[-]plexes dried at 70° C. fixed the largest quantiti[es]. The iron phosphate fixed 72.15 milliequivalents of [K] per 100 grams, which represents 57.85 per cent. [of] the total KCl applied, and aluminum phosphate fix[ed] 71.43 milliequivalents, which represents 57.14 per cen[t.] of the KCl applied.

Other cation linkages have been tested under vario[us] conditions and they also were found to fix the K.

There is an indication that the NH_4 ion and perha[ps] other cations may be fixed in the same manner.

Pedological data on hand seem to fit in with t[he] findings of the laboratory experiments on the fixati[on] of K through the medium of phosphated complex[es]. There is a definite relation between the phosphat[e] complexes of various cation linkages and the exte[nt] of K fixation.

A more detailed description of the data on han[d], the probable chemical reactions involved in the mo[de] of fixation of K by the phosphate complexes, and t[he] implications involved with respect to systems of fert[i]lization will be dealt with in a more extensive mann[er] in a paper to be submitted to *Soil Science*.

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[1] Journal Series paper of the New Jersey Agricultural Experiment Station, department of soil chemistry and bacteriology.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW TECHNIQUE FOR PRODUCING LESIONS OF THE ENCEPHALON CORTEX

TECHNIQUES for producing controlled lesions of the encephalon that are uniform in depth and limited to the cortical layers are comparatively crude and unsatisfactory. This is particularly the case when large lesions are desired and when chronic preparations a[re] necessary. With small animals such as the rat, adde[d] difficulties arise from the spatial limitations of t[he] small field of operation.

By adapting the copper point of an electric solder[-]ing iron, Dusser de Barenne[1,2] has devised probabl[y]

[1] J. G. Dusser de Barenne, *Zeit. f. d. Ges. Neur. Psychiat.*, 147: 280, 1933.

the best instrument to date. Several limitations of his technique of destruction, which are obviated by the method to be described herein, are deserving of mention. When the soldering iron technique is employed the area to be destroyed must be fully exposed. This requires the removal of bone equal to or in excess of the size of this area. Any minimizing of bone removal, especially when large areas are to be ablated, is conducive to a lessening of the operative shock and therefore increases the chances of survival of the animal. Direct entrance to regions along the ventral borders of the cortex requires the removal of surrounding bony structures. Certain of these deeper portions would be very difficult to reach with the copper heat applicator. Judging from photographs published by Dusser de Barenne of lesions produced by this method, there is considerable tendency for the middle portion of the destruction to invade the tissues more deeply than does the peripheral portion. This tendency was also encountered in devising our method, but apparently can be controlled to a greater extent than with the other technique.

A low voltage radio frequency thermo-coagulator,[3] developed for the production of controlled injury in the interior of tissue masses, has been successfully adapted to the problem of cortical destruction. The electrodes consist of two thin strips of spring-tempered steel 1 mm wide, .05 mm thick and 7 mm in length. They are soldered to two small brass pieces $.7 \times 4 \times 10$ mm, riveted to a rectangular bakelite handle $2 \times 10 \times 50$ mm. The strips are arranged parallel, with their flat surfaces in the same plane, and are separated by 3.5 mm. The brass pieces extend longitudinally about 3 mm beyond the end of the bakelite, the extended parts being bent 45° so that the plane of the electrodes intersects the plane of the handle at its end. Light-weight flexible connection wires are attached to the brass pieces. The soldering of the steel strips to the brass pieces is best carried out while holding the two strips together and in alignment with a small toolmaker's parallel jaw clamp. The brass parts are coated with bakelite insulating varnish.

The electrodes are inserted through a pair of small holes made with a dental drill trephine and are carefully slid between the dura and the inner surface of the skull into the desired position. Since the steel strips are quite flexible, they follow the curvature of the skull within limits. Applying approximately 16 volts of radio frequency energy across the electrodes destroyed the cortical tissue to a depth of .8 mm and to a width of 6 mm along the entire length of the electrodes. Variation in the depth of destruction can be obtained by varying the magnitude of the voltage and the duration of the exposure. When smaller localized lesions are desired a suitable portion of the electrode surface is rendered inactive through the application of insulating varnish. It is possible in this way to create local lesions in areas that are inaccessible to other methods without considerable incidental destruction, although the electrodes are more difficult to place because of their added stiffness. Larger areas of destruction can be obtained by using larger electrodes and increasing the spacing between them.

Uniform results can only be secured with a properly designed source of radio frequency energy.[4] The cross-sectional shape of the lesion is affected by the width and spacing of the steel strips, the voltage and current density and the duration of the exposure. Incorrect parameters may lead to lesions surrounding each electrode only or to a single ellipsoidal region instead of the desired contour approximately rectangular in shape. Calibration may be most conveniently carried out through the use of a rapid method developed by one of the writers for investigating the action of radio frequency currents in cell masses.[5] Blocks of tissue from the root of the common garden beet are used. The electrodes are placed on a freshly cut surface of this material and covered with a glass slide. After exposure to the current, free-hand sections of about .5 mm are cut and soaked in tap water for one or two hours. Cells that have been injured will suffer a loss of pigment and become clearly differentiated.

Calibrations made in this way will not hold precisely in the living animal because of the influence of structures characteristic of the vegetable cell, and because of the cooling and distributing action of blood circulation in the animal. Nevertheless, the results are in approximate agreement. A few brain sections worked up by the conventional method, supplemented by preliminary experiments with the beet tissue, avoids much of the really formidable amount of work that is otherwise expended in preparing sections. This method also has proved very useful in developing the technique for producing internal lesions in cell masses.

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A METHOD OF MOUNTING MAPS

Mounting of maps on muslin or linen for use in the field or in the classroom is standard practice in

[2] J. G. Dusser de Barenne and H. M. Zimmerman, *Arch. of Neur. and Psychiat.*, 33: 123, 1935.

[3] C. W. Brown and F. M. Henry, Science, 79: 457, 1934.

[4] C. W. Brown and F. M. Henry, *Proc. Nat. Acad. Sciences*, 20, 310, 1934.

[5] F. M. Henry, *Yearbook Carnegie Inst. of Wash.*, 30: 265, 1930.

geology and related sciences. The usual method involves wetting the cloth and the map, stretching the cloth on a mounting board, spreading paste on its surface, and smoothing and pressing the map with a rubber roller. The process is time-consuming, since the map must be allowed to dry completely before it is removed from the board. The necessary soaking of the map may cause an appreciable change in scale, or may damage certain colored maps. Subsequent unavoidable wettings in the field may loosen the paste or cause the cloth to shrink. An alternate method, which involves the use of paper-thin sheets of a pliable wax-like substance, known as Parafilm,[1] has been developed during the last two years at the University of Washington, having been first suggested by Mr. Allen Cary, a graduate student in the department of geology. Much interest expressed by visiting professors has suggested the desirability of a brief description of the method, so that it may be tested and used by others who work with maps.

The wax-like sheeting is sold in rolls of varying widths; the twenty-inch width has been found most convenient. The table top to be used in mounting should be covered by cardboard or paper, which can be replaced when it is soiled. If the map to be mounted is a single sheet it should be laid on the table, face down, and covered completely with a sheet of Parafilm. The film may be stretched to approximately one and one half times its original length or width before it is cut to size, but it is doubtful whether the slight saving effected by this procedure justifies the loss of time. The sheet (or sheets) of the film need not be perfectly smooth. A piece of muslin or linen slightly larger than the map should then be spread over the two layers. Wrinkles and creases may be eliminated by thumbtacks near the margins, but the cloth must not be stretched. Finally the three layers should be pressed with a moderately hot pressing iron, at first rapidly around the margins (since Parafilm tends to contract slightly when warmed near the iron), and then more slowly over the whole surface until the melted film has completely sealed every part of the cloth to the map. The mounted map may then be removed from the table and trimmed.

If necessary, two or more pieces of cloth may be joined by placing a one half inch strip of Parafilm between the overlapped edges and pressing with the iron.

If the map consists of a number of sheets that must be matched or if it is to be mounted in sections so that it may be folded for use in the field, a slightly different procedure is recommended. The cloth should be spread out on the table, held in place (not stretched) with thumbtacks, and covered with the film. The sections of the map should be laid on the film in the desired position, with no overlap, and fixed in place by pressing with the iron directly on the surface or through a sheet of heavy paper, but the iron should not be passed over the seams lest the film be drawn through and smeared over the map. When all the sections have been fixed the whole mount should be turned over and pressed thoroughly on the reverse side, as before. If Parafilm from the seams seals the mount to the cardboard it may be freed by heating with the iron.

Mounted groups of topographic sheets can be prepared for use as wall maps by attaching "half-round" wooden strips at the top and bottom margins and fitting with hooks and tie cords. Over 40 such group sheets have been prepared, at small expense, for use in geology courses at the University of Washington. Our aim is to provide, wherever practicable, group sheets showing regional relations of features which appear on individual topographic maps assigned for laboratory study.

If a map is to be used in the field it may be protected from damage by water by drawing a very thin film of the same wax sheeting over the surface with the pressing iron. If very high temperatures prevail in the district where the map is to be used a thin coating of flexible lacquer may be applied to the surface of the map, before mounting, in place of the Parafilm.

The method outlined above commends itself because it is economical and ideally simple, and because it does not damage the map. If it is necessary to make a tracing from a field sheet, or to replace one section of a group mount with a later edition of the same quadrangle, the map can be detached from the cloth by heating with the iron. Maps in use for two years show no signs of stiffening or loss of adhesive properties of the film.

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[1] Made by the Marathon Paper Mills Company, Rothschild, Wis.

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